Updates to SNF Quality Measures Risk Adjustment

A study conducted by staff from the Division of Health Care Policy and Research, University of Colorado Denver for the Medicare Payment Advisory Commission

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1 Introduction

In June 2006, the University of Colorado Division of Health Care Policy and Research conducted research to develop two SNF quality measures for the Medicare Payment Advisory Commission (MedPAC)[1]. These measures were rehospitalization and community discharge of SNF admissions. This work has been updated annually to address trends in these measures and factors associated with the two measures[2;3]. MedPAC has reported on these results in their annual reports[4-8]. These measures are increasingly being used in various Centers for Medicare & Medicaid Services (CMS) programs such as value-based purchasing and care transition initiatives. Research by the University of Colorado team as well as other researchers have led to improvements in our understanding of risk adjustment for these measures [9-12]. The purpose of this report is to update the risk adjustment conducted by the University of Colorado for future MedPAC studies.

One important issue to address is that the comorbidity indices needed to be updated including more recent data. These indices were derived for each of the quality measures using the method described by Romano[13]. Previously, a sample of 2004 data was used to construct the comorbidity indices and applied to all years. It is plausible for the same disease condition to have a different effect on the outcomes from year to year for various reasons such as a change in ICD-9 coding, a change in treatment, or changes in disease burden for the population under study. Thus, the following analysis examines changes in weights for the comorbidities over time and updating the indices accordingly.

Another resident-level adjustor was a binary variable indicating if the patient was in a rehabilitation RUG. The use of several binary indicator variables for the categorical rehabilitation RUG variable (for example, low rehabilitation RUG or very high rehabilitation RUG) instead of the binary variable previously used could provide a better model fit. The previous resident-level risk-adjustment model to estimate the expected rate of each measure utilized only SNF stays from the year 2004. Because the determinants of risk and their effects may be time dependent, risk-adjustment might be enhanced based on data from different time points.

In the earlier resident-level models, a variable indicating whether the resident was residing in a hospital-based or freestanding facility was used as a case mix proxy. Since more and improved resident case mix variables are now available and with the decline in the number of hospital-based facilities, the hospital-based/freestanding variable was removed from the resident-level risk adjustment model. Hospital-based/freestanding is still included as an explanatory variable in the facility-level model to determine the effect of residing in a hospital-based facility, after adjusting for resident case mix.

With current national attention on geographic variation in healthcare, more granularly defined geographic variables should be considered to account for small area variation. Previously four regions (Northeast, Midwest, and South vs. West) were used as geographic variables in the facility-level analysis. The Dartmouth Atlas of Health Care variables and state indicators were used as geographic measures in the current analysis.

In this paper, the updated methodology is compared to the original methodology to identify differences resulting from updating the risk adjustment in trends over time and results for individual or groups of facilities.

2 Methods

2.1 Data sources and sample

The national DataPRO Skilled Nursing Facility (SNF) Stay File, containing information on Medicare-covered SNF stays linked with the preceding qualifying hospitalization and any rehospitalization was used in all analyses. This file contains information from Medicare claims, the Minimum Data Set (MDS), and the Online Survey Certification and Reporting (OSCAR) system; file documentation is available elsewhere[1;14]. OSCAR-reported staffing levels for 2000 through 2006 were used to supplement the DataPRO SNF Stay File for these analyses. The OSCAR staffing data editing rules proposed by Abt Associates[15] were applied. Selected variables from the The Dartmouth Atlas of Health Care data files (derived from Medicare claims) were explored for use. The Dartmouth Atlas of Health Care data files are publicly available for download at (http://www.dartmouthatlas.org/data/download.shtm). These sources were combined at the facility level to create a single analysis file. Analysis of the stability and variability of the risk-adjusted rates indicated that a minimum sample of 25 or more stays (excluding deaths) over one year was required for estimates to be sufficiently stable[1]. The analysis file was therefore restricted to only those SNFs with at least 25 stays (excluding deaths) with known outcome for any year between 2000 and 2006. This analysis file was an update to the file used in a previous report to MedPAC[3] and slightly different cases were included even for the common years from 2000 to 2005.

2.2 Measures

2.2.1 Comorbidity index

The estimated coefficients from a logistic regression model for each outcome using 17 ICD-9 based disease condition binary indicators initially developed by Charleson/Deyo[16] were used to construct the comorbidity indices. Originally, a 3% sample of 2004 data was used to construct the comorbidity indices (excluding the intercept). Because the same disease condition can have a different effect on the outcomes from year to year, an updated set of comorbidity indices, one for each year, were constructed for each outcome measure using the estimated coefficients, the intercept, and all available SNF stays for each year (2000-2006). The same 17 ICD-9 based disease conditions were used for each year. For both the original and updated models, the comorbidity indices included only those coefficients with a chi-squared test with probability of 0.05 or less.

For each stay, the appropriate index and intercept for the corresponding year is used in the updated risk adjustment. Because data are now pooled from several years in the stay-level regression for risk-adjustment, the construction of the updated comorbidity index for each year should include the intercept term in addition to the coefficients for individual conditions in order to capture potential year-to-year variation of the baseline risk level in comorbidity. For example, suppose the respective coefficients of CHF and HIV are -0.34 and -0.30 for 2000 and -0.40 and -0.65 for 2006 in the comorbidity model for community discharge. Ignoring other conditions for simplicity, the relative contribution of CHF and HIV over time is apparent. For example, HIV becomes a larger component of the comorbidity index in 2006. When comparing between years for residents with the same conditions, the comorbidity index for a resident with both CHF and HIV goes from -0.64 in 2000 to -1.05 in 2006 by adding up individual coefficients each year. This suggests a lower chance of community discharge in 2006. It is, however, possible for a resident with both conditions to have a larger chance of community discharge in 2006 by having a larger intercept, say 1.00 for 2000 and 2.00 for 2006. This should be reflected by constructing

comorbidity indices that include the intercept (0.36 for 2000 and 0.95 for 2006 using the hypothetical coefficients and intercepts).

2.2.2 Risk-adjustment

The original resident-level risk-adjustment model used SNF stays from the single year 2004 of the SNF stay file. Because the risk relationship may be changing over time, the application of a risk model should be limited to cross-sectional data or data within a short time span from the time frame of the data used. With the availability of additional years of data, it was appropriate to develop a new risk-adjustment model encompassing all available years (2000 to 2006) of data for the analysis. Rather than developing a risk model for each year, which may reflect time varying effects of risk predictors, to enhance the comparison of risk-adjusted rates across years, data from all years were pooled for developing one risk model for all years.

Updated predictors included the temporal comorbidity indices and a set of five binary indicator variables for rehabilitation RUG (ultra high, very high, high, medium, and low vs. other categories). Originally hospital-based/freestanding classification, which is a facility-level variable, was used as a predictor in the risk-adjustment model because only a limited set of variables were available, and the hospital-based/freestanding variable is a proxy for unmeasured resident characteristics. In the updated risk model, the variable was left out from the candidate predictor list so that differential risk-adjusted rates across facilities could be explained without a bias by whether or not the facility was hospital-based.

2.2.3 Facility characteristics

Resident characteristics were aggregated to the facility level to obtain facility case mix measures. The specific resident characteristics aggregated were the set of measures used previously for resident-level risk adjustment, some of which were updated,[1] and several new measures found to be significant in the updated risk-adjustment. The facility case mix indicators included demographics, presence of advance directives, the Barthel Index (a measure of functional independence, ranging from 0 for most dependent to 90 for most independent)*, the Cognitive Performance Scale (a measure of cognitive impairment, ranging from 0 for least impaired to 6 for most impaired), selected MDS items, a weighted comorbidity index[1], selected comorbid conditions (ICD-9 based conditions from the qualifying hospitalization), and length of stay of the qualifying hospitalization. The comorbidity index was updated as described in Section 2.2.1 and a set of five categorically defined variables was used for rehabilitation RUG as described in Section 2.2.2.

Facility characteristics included OSCAR-reported staffing levels for RN, licensed nursing (defined as RNs, LPNs, DONs, and nurses with administrative duties), and CNA hours per resident-day. Facility characteristics also included hospital-based/freestanding, urban/rural, ownership, and region. The Dartmouth Atlas of Health Care variables and state indicators were alternative geographic characterization of facilities. The Dartmouth Atlas of Health Care variable “Primary care physicians per 100,000 residents” from the *selected hospital capacity and physician workforce measures* data file was used for community discharge (2006 only). The “Percent of Medicare decedents hospitalized at least once during the last six months of life” variable from the *selected measures of inpatient utilization during the last six months of life* data file (2000-2005) was used for rehospitalization. These two variables were selected for modeling

* Climbing stairs is not available on the MDS resulting in a 90 point scale in contrast to the original 100 point Barthel Index.

based on Pearson correlation analysis. The Dartmouth Atlas of Health Care data are available for 457 Hospital Referral Regions (HRR) in the US.

2.2.4 Outcome measures

Two outcome measures were investigated: observed rate of community discharge and observed rate of rehospitalization for any of the following five conditions: heart failure, electrolyte imbalance, respiratory infection, sepsis, and UTI. Both measures were assessed at 100 days after SNF admission and excluded residents who died in the SNF before 100 days.

Community discharge was defined as direct discharge from the SNF to home or assisted living. However, if a resident was discharged to the community but then hospitalized within one day, the stay was reclassified as a rehospitalization and not a community discharge.

The rehospitalization measure was limited to hospitalizations with ICD-9-CM codes for heart failure, electrolyte imbalance, respiratory infection, sepsis, or UTI - conditions for which rehospitalization may be potentially avoidable. Rehospitalization was defined as an admission to an acute care or critical access hospital. Any such rehospitalization that occurred within one day of SNF discharge (regardless of discharge location) also was considered a rehospitalization.

2.3 Changes in outcomes over time

For each of the two outcomes (community discharge and rehospitalization), simple descriptive statistics were computed by year at the facility level. Because it was determined that the 100-day measures were more stable as quality measures[3], only 100-day outcome measures for both outcomes were considered in describing temporal rate changes. Unadjusted facility observed rates and facility-level adjusted rates[17] were calculated for all years from 2000 to 2006. Subsequent analyses were limited to explaining 2000 and 2006 observed rates within 100 days for both community discharge and rehospitalization. All analyses focused on the contrast between the updated methodology and the original methodology for any differences in the models, national trends, and also for the variation in individual or groups of facilities.

Prior studies[2;3] suggested that facilities that were present for both the beginning and the end of the analysis period had different outcome rates than facilities that were present only in the beginning or only at the end. "Presence" required at least 25 observations (excluding deaths) for which the outcome was not missing. A facility might be "not present" if it had fewer than 25 stays or if it was not in business at all. Unadjusted comparisons of facility characteristics were made with the group of facilities initially present regardless of status at the end and with the group of facilities present at the end regardless of status in the beginning.

2.4 Regression models for outcomes

The data were restricted to only years 2000 and 2006, and pooled so that each facility year was a separate record. A dichotomous variable (time) indicated whether the observation was from 2000 or 2006. Two binary variables were constructed indicating whether the facility was present in the data file in 2000 but not in 2006 (2000 only) or if the facility was present in the data file in 2006 but not in 2000 (2006 only). The reference group was facilities present at both time points. A series of preliminary regression models were fitted to assess the crude impact of various facility measures on outcome rates. The first set of models additively included time, the two binary variables, and a set of case mix variables as predictors. Each facility measure (or

sometimes a set) was then added and tested. The model adjusted R^2, the estimated coefficient of the variable being tested, the estimated coefficients of time, and the two dummy variables were assessed for each model. Variables tested in this manner included: hospital length of stay, region, staffing levels, hospital-based versus freestanding, urban versus rural, ownership, Dartmouth Atlas of Health Care variables, and state indicators.

Two final models (with region) were fitted using all tested variables together, first excluding the OSCAR-reported staffing for licensed nursing and CNA. The magnitude of the coefficient of a facility type variable can be influenced by variables associated with facility type, especially staffing levels. For example, hospital-based facilities generally have significantly higher staffing levels than freestanding SNFs. If the magnitude of the coefficient of hospital-based facilities drops significantly in the second model including the staffing variables, much of the effect of hospital-based facilities can be explained by differences in staffing levels. Because RNs represent a significant portion of licensed nursing staff, the RN and licensed nursing staff variables are highly correlated (r = .80). Thus, we included only licensed nursing in the final model. The staffing variable model was re-examined using The Dartmouth Atlas of Health Care variables and state indicators as geographic measures.

3 Results

3.1 Comorbidity index

Regression results for the comorbidity indices for community discharge and rehospitalization are provided in Tables 1A and 1B, respectively. Estimated coefficients from the model predicting each outcome for each year were compared across years. There were some year-to-year fluctuations and also upward and downward trends over time. For community discharge, a substantial change between 2000 and 2006 was noted in hemiplegia/paraplegia, metastatic solid tumor, and HIV/AIDS. For rehospitalization, a substantial change was noted in dementia, diabetes (mild to moderate), metastatic solid tumor, and HIV/AIDS. The intercept terms showed some fluctuations across years, indicating variation in general risk level of the comorbidities. The coefficients for the original comorbidity index appeared roughly similar to the updated year 2004 comorbidity index, with a possible exception for HIV/AIDS, which showed the largest change between years in the updated models. The c-indices and p-values appeared consistent across all models, except there were a few more non-significant comorbidities in the original model, possibly due to a smaller sample size. The year-to-year variation of the effects of comorbidities on outcomes can only be estimated through separate modeling for each year. Risk adjustment that accounts for this year to year change in the weights of comorbidities offers an improvement over risk adjustment based on a static index when trending outcomes over time.

3.2 Risk-adjustment

Risk-adjustment models for community discharge and rehospitalization are show in Tables 2A and 2B, respectively. For each outcome, the model using original methodology was compared to the model using updated methodology. A number of new variables were found to be significant in each outcome model and also some variables that were significant in the original model became non-significant and dropped out of the updated model. Significance was defined as increasing the c-index by at least .002 with stepwise addition of each variable. Excluding the hospital-based/freestanding variable and adding the new and revised variables changed the coefficients of some variables. However, these improvements had a negligible effect on the c-index of the overall models for both measures.

Overall those variables that contributed most to explaining outcome variation were the same for the original and updated models. For community discharge, the primary explanatory variables were Barthel Score, CPS, rehabilitation and comorbidity index. For rehospitalization, the primary explanatory variables were Barthel Score, comorbidity index, pressure ulcer, feeding tube and catheter. The coefficient estimates were generally similar for a particular variable comparing the original and updated models. In addition, the overall c-index remained essentially the same for both models with a fewer number of variables (treating the categorical rehabilitation RUG variables as one variable) in the updated models, possibly indicating the updated comorbidity index was more robust and compensated for the absence of the hospital-based/freestanding variable in the updated models. Risk-adjusted facility outcome rates can be compared more meaningfully using the updated resident-level models.

3.3 Change in facility outcomes from 2000 to 2006

Unadjusted facility observed rates and facility-level adjusted rates of the two outcome measures from 2000 through 2006 are presented in Table 3. The average rate and the difference in average rate between years are shown for each outcome.

The adjusted rates using the original methodology and the adjusted rates using updated methodology were compared. The general trends in both community discharge and rehospitalization were the same in the original and updated models. The rates of community discharge within 100 days were stable with a marginal increase of the average rate by less than one percentage point between 2000 and 2006. In contrast, the rates of rehospitalization within 100 days increased over time between 2000 and 2006.

The original and updated methodologies resulted in relatively similar rates for adjusted rates of community discharge throughout the years. However, for rehospitalization the improved risk models resulted in higher adjusted rates earlier in the period (11.79% vs. 13.72% in 2000) before catching up to a similar range around year 2004 (17.12% vs. 17.51%) and then a slightly higher rate in 2006. The impact of excluding the hospital-based/freestanding variable in risk-adjustment for the rehospitalization model and the temporal comorbidity index may explain these differences in adjusted rates of rehospitalization. There has been a significant decline in hospital-based facilities (13.3% in 2000 to 7.4% in 2006, See Table 4) which may explain the initial low rates of rehospitalization. The use of only 2004 data in the original methodology may have also caused the 2000 rate to decrease.

The increase (11.79% to 17.12%) in the adjusted rates of rehospitalization between 2000 and 2004 using the original methodology[(1)] is now more moderate (13.72% to 17.51%), but still significant. Although rehospitalization rates still increased between 2004 and 2006, the rate of increase in rehospitalization appeared to be gradually declining since 2004 using both models.

Figures 1 and 2 plot the ranks of the facility risk-adjusted rate based on the updated methodology (horizontal axis) vs. the facility risk-adjusted rate based on original methodology (vertical axis) for each outcome in 2006. The ranks are collapsed into 1000 ranks for each year. Year 2000 plots were similar. A 45 degree line would indicate no changes in ranks. For community discharge, there are facilities significantly below the 45 degree line, where rankings of adjusted rates became substantially higher (better quality) with the updated methodology. For rehospitalization, there were facilities whose rankings of adjusted rates became substantially lower (still better quality). The facilities around the 45 degree line were more narrowly concentrated for rehospitalization. Thus, the updated risk adjustment did alter the

relative ranks of some individual facilities, which would be expected with the changes in the model.

3.4 Changes in case mix and facility characteristics from 2000 to 2006

A comparison of all independent variables between 2000 and 2006 is shown in Table 4. In aggregate, changes in resident case mix between 2000 and 2006 appear modest. The larger changes include increases in the percent of residents with DNR orders, receiving parenteral IV feeding, with genitourinary conditions, with hypertension, with musculoskeletal disorders, with depression, or with schizophrenia and decreases in the percent of resident being tube-fed or with fractures. The average length of stay of a resident's prior qualifying hospital stay declined by more than half a day from 9.3 to 8.5 days. There were significant shifts in rehabilitation with an overall increase from 74.6% to 82.6%, the distribution of rehabilitation with more in the higher categories, and also a shift from the High category (41.0% to 16.6%) to the Medium category (18.3% to 37.8%). Average staffing levels dropped for RN and licensed nursing and increased slightly for CNAs. There were small shifts in geographic distribution, with the South and Midwest experiencing slight increases and the Northeast and West experiencing slight decreases. The percentage of SNFs that were hospital-based dropped from 13.3% to 7.4% and urban facilities decreased from 71.2% to 68.4%. The percentage of SNFs that were for-profit increased modestly. The number of primary care physicians per 100,000 residents on average was 71.63 in 2006. Data prior to 2006 were not available. For percent of Medicare decedents hospitalized at least once during the last six months of life there was a slight increase from 70.57% in 2000 to 71.20% in 2005 on average. Data in 2006 was not available.

3.5 Community discharge and rehospitalization within 100 days

3.5.1 Trend analyses

In the stepwise preliminary analyses (Tables 5A, 5B, 7A, and 7B) to assess the crude impact of various measures on outcome rates, the updated methodology increased the R-square for the models which includes case mix variables. This was not surprising because the updated variables, such as the comorbidity index, were clearly much better defined. Coefficients of tested variables, time, and two dummy variables representing facilities present in one year only were somewhat affected. Alternative geographic variables showed some contribution to the R-square. State indicators showed a larger impact on the adjusted R-square than The Dartmouth Atlas of Health Care variables after adjusting for case mix for both outcomes.

3.5.2 Multivariable analyses for community discharge

In the multiple regression models (Tables 6A and 6B), which assess the adjusted effects of the predictor variables on community discharge rates, the updated methodology increased the R-square by more than 0.025. Among the coefficients with larger changes were hospital-based (0.146 to 0.122 without staffing and 0.096 to 0.082 with staffing) and for-profit (0.008 to 0.003 [non-significant] without staffing and 0.012 to 0.007 with staffing). The use of alternative geographic variables with staffing (Tables 6C and 6D) further increased the R-square and explained state variation as large as 0.28 between North Dakota in the Midwest and Montana in the West. The coefficient of the Primary care physicians per 100,000 residents was significant in these models.

3.5.3 Multivariable analyses for rehospitalization

In the multiple regression models (Tables 8A and 8B) to assess the adjusted effects of predictor variables on rehospitalization rates, the updated methodology did not change the R-square appreciably (less than 0.005). The coefficients for facility characteristics did not change substantially either. However, the use of alternative geographic variables with staffing (Tables 8C and 8D) increased the R-square by almost 0.02, and explained state variation as large as 0.07 between Connecticut in the Northeast and Hawaii in the West. The coefficient of the percent of Medicare decedents hospitalized at least once during the last six months of life was significant in these models.

4 Discussion

A rigorous methodology was used several years ago in the development of two risk-adjusted SNF quality measures: community discharge and rehospitalization[(1)]. However, growing emphasis on care transitions and value in health care has prompted more research and greater scrutiny of these metrics. As such measures are increasingly used for different purposes, it is expected that new issues will be raised suggesting alternative methodologies. The increased attention, particularly to measures of rehospitalization, prompted this analysis that emphasized enhancing risk adjustment models and more granular methods of accounting for geographic variations in health care.

Because of the critical importance of adequately accounting for comorbidity in risk adjusting these outcome measures, the relative impact (or weights) of comorbid conditions was assessed over time. Trends in the relative importance of the17 comorbid conditions were found in relation to both of these quality measures, suggesting the need to update comorbidity indices on a regular basis. To ensure that future trend analyses take into consideration these changes in comorbidity weights, we recommend utilizing methods like those reported here. In these analyses, comorbidity indices were derived from the data corresponding to all time periods of interest and the appropriate weights were applied for each period.

Other enhancements to the risk adjustment models improved the model R-square, while eliminating a controversial proxy variable from the model. The geographic variables corresponding to national regions were replaced with far more granular The Dartmouth Atlas of Health Care variables and dummy variables for each state, further improving the model R-square. These changes had some impacts on individual facility ranks in the quality measures, suggesting the importance of these types of enhancements when comparing these outcomes between individual facilities.

Interestingly, the time trends and the aggregate facility factors related to these outcomes did not change substantially with these improvements to the risk models. Some of the effects appeared somewhat larger or smaller with the improved models, but the direction and the significance of the effects remained similar. This suggests that the aggregate empirical findings based on these two risk-adjusted quality measures are quite robust. Going forward, we recommend the use of these more rigorous modeling approaches in reporting results related to these two measures.

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TABLES

Table 1A: Coefficient Estimates for Community Discharge Resident Level Comorbidity Index

	Original[1]	Updated Coefficient Estimate[2]							
		2000	2001	2002	2003	2004	2005	2006	Trend
00 Intercept	N/A	0.001	-0.026[3]	-0.048	-0.056	-0.038	-0.004[3]	0.017	•
01 Myocardial Infarction	0.046[3]	0.109	0.070	0.070	0.062	0.053	0.040	0.043	↘
02 Congestive Heart Failure	-0.365	-0.345	-0.358	-0.362	-0.371	-0.388	-0.416	-0.399	↗
03 Peripheral Vascular Disease	-0.220	-0.140	-0.152	-0.159	-0.173	-0.173	-0.172	-0.177	↗
04 Cerebrovascular Disease	-0.293	-0.377	-0.372	-0.359	-0.349	-0.345	-0.363	-0.347	↘
05 Dementia	-1.179	-1.252	-1.248	-1.247	-1.230	-1.197	-1.188	-1.179	↘
06 Chronic Pulmonary Disease	-0.150	-0.040	-0.069	-0.072	-0.088	-0.104	-0.116	-0.124	↗
07 Rheumatologic Disease	-0.222	0.185	0.181	0.174	0.150	0.154	0.157	0.144	↘
08 Peptic Ulcer Disease	-0.204	-0.196	-0.212	-0.224	-0.195	-0.181	-0.200	-0.194	•
09 Mild Liver Disease	-0.115[3]	-0.072	-0.072	-0.072	-0.072	-0.091	-0.117	-0.129	↗
10 Diabetes, Mild to Moderate	-0.134	-0.098	-0.114	-0.124	-0.143	-0.144	-0.129	-0.129	↗
11 Hemiplegia or Paraplegia	-0.539	-0.393	-0.431	-0.432	-0.466	-0.505	-0.539	-0.569	↗
12 Renal Disease	-0.429	-0.407	-0.416	-0.423	-0.421	-0.433	-0.414	-0.371	•
13 Diabetes w/ Chronic Comp.	-0.098	-0.050	-0.085	-0.099	-0.105	-0.118	-0.139	-0.145	↗
14 Any Malignancy (Lymp/ Leuk)	-0.057[3]	0.002[3]	-0.015	-0.017	-0.015	-0.037	-0.026	-0.045	↗
15 Moderate/Severe Liver Disease	-0.369	-0.361	-0.355	-0.367	-0.392	-0.423	-0.450	-0.422	↗
16 Metastatic Solid Tumor	-0.193	-0.151	-0.167	-0.184	-0.242	-0.262	-0.295	-0.309	↗
17 HIV/AIDS	-0.817	-0.300	-0.474	-0.464	-0.503	-0.488	-0.470	-0.646	↗
Logistic Model c-index	*0.62*	*0.62*	*0.62*	*0.62*	*0.62*	*0.62*	*0.63*	*0.63*	•

[1] The original model was based on a 3% random sample of SNF stays from year 2004 and did not use the intercept.

[2] The updated models were based on all SNF stays for each year 2000 to 2006.

[3] Coefficients with probabilities greater than .05 excluded that coefficient from the comorbidity construct.

Table 1B: Coefficient Estimates for Rehospitalization Resident Level Comorbidity Index

	Original[1]	Updated Coefficient Estimate[2]							
Comorbidity		2000	2001	2002	2003	2004	2005	2006	Trend
00 Intercept	N/A	-2.310	-2.202	-2.124	-2.057	-2.028	-1.990	-1.973	↘
01 Myocardial Infarction	0.087	0.102	0.111	0.108	0.110	0.114	0.112	0.108	•
02 Congestive Heart Failure	0.612	0.611	0.604	0.595	0.604	0.615	0.614	0.597	•
03 Peripheral Vascular Disease	0.219	0.154	0.155	0.152	0.155	0.169	0.134	0.137	•
04 Cerebrovascular Disease	0.082	0.148	0.145	0.123	0.117	0.106	0.123	0.104	↘
05 Dementia	0.026[3]	0.155	0.125	0.105	0.065	0.013	0.003[3]	-0.017	↘
06 Chronic Pulmonary Disease	0.201	0.222	0.224	0.219	0.218	0.217	0.225	0.214	•
07 Rheumatologic Disease	-0.026[3]	-0.001[3]	-0.008[3]	0.011[3]	0.013[3]	0.016[3]	0.018[3]	0.015[3]	•
08 Peptic Ulcer Disease	0.036[3]	0.169	0.150	0.149	0.143	0.117	0.134	0.102	↘
09 Mild Liver Disease	0.155[3]	0.215	0.194	0.191	0.182	0.176	0.201	0.202	•
10 Diabetes, Mild to Moderate	0.085	0.145	0.126	0.111	0.107	0.088	0.065	0.043	↘
11 Hemiplegia or Paraplegia	0.242	0.183	0.204	0.204	0.213	0.232	0.233	0.244	↗
12 Renal Disease	0.505	0.533	0.517	0.517	0.528	0.532	0.518	0.482	•
13 Diabetes w/ Chronic Comp.	0.173	0.177	0.168	0.174	0.166	0.144	0.148	0.148	↘
14 Any Malignancy (Lymp/ Leuk)	0.127	0.166	0.155	0.164	0.161	0.186	0.194	0.196	•
15 Moderate/Severe Liver Disease	0.401	0.373	0.370	0.365	0.395	0.377	0.410	0.369	•
16 Metastatic Solid Tumor	0.175	0.100	0.115	0.131	0.177	0.185	0.188	0.250	↗
17 HIV/AIDS	0.715	0.258	0.414	0.472	0.443	0.405	0.331	0.426	↗
Logistic Model c-index	*0.63*	*0.62*	*0.62*	*0.62*	*0.62*	*0.62*	*0.62*	*0.63*	•

[1] The original model was based on a 3% random sample of SNF stays from year 2004 and did not use the intercept.

[2] The updated models were based on all SNF stays for each year 2000 to 2006.

[3] Coefficients with probabilities greater than .05 excluded that coefficient from the comorbidity construct.

Table 2A: Immediate Discharge to Community from SNF Resident Level Risk-Adjustment Models

Original (Uses 2004 SNF Stays)		
Independent Variable	Beta	OR
Intercept	-1.3475	
Barthel Score (0 to 90)	0.0175	1.018
Cognitive Performance Score (0 to 6)	-0.2480	0.780
Rehabilitation (1,0)	0.9485	2.582
Comorbidity Index (-3.26 to 0.22)	0.4693	1.599
Musculoskeletal Disease (1,0) [1]	0.2422	1.274
Bowel Incontinence (1 to 4) [1]	-0.0884	0.915
Pressure Ulcer (1,0) [1]	-0.1719	0.842
Do not Resuscitate (1,0)	-0.4233	0.655
Hospital Based Facility (1,0) [2]	0.9375	2.554
N=2,000,787		
Logistic Model c-index	0.784	

Updated (Uses 2000-2006 SNF Stays)		
Independent Variable	Beta	OR
Intercept	-1.3785	
Barthel Score (0 to 90)	0.0248	1.0250
Cognitive Performance Score (0 to 6)	-0.2675	0.7650
Rehabilitation-Ultra High (1,0)	1.2646	3.5420
Rehabilitation-Very High (1,0)	1.1272	3.0870
Rehabilitation-High (1,0)	0.7806	2.1830
Rehabilitation-Medium (1,0)	0.5727	1.7730
Rehabilitation-Low (1,0)	0.4814	1.6180
Comorbidity Index (-3.37 to 0.29)	0.5237	1.6880
Depression (1,0) [3]	-0.3932	0.6750
Schizophrenia (1,0) [3]	-1.1789	0.3080
Do not Resuscitate (1,0)	-0.4424	0.6420
Married (1,0) [3]	0.4655	1.5930
N=13,182,779		
Logistic Model c-index	0.788	

[1] Original variable that was no longer significant in the updated model.

[2] Original variables intentionally excluded from the updated model.

[3] New significant variable included in the updated model.

Table 2B: Five Potentially Avoidable Rehospitalization within One Day of SNF Resident Level Discharge Risk-Adjustment Models

Original (Uses 2004 SNF Stays)		
Independent Variable	Beta	OR
Intercept	-1.4067	
Barthel Score (0 to 90)	-0.0182	0.982
Comorbidity Index (0.00 to 2.31)	0.8998	2.459
Pressure Ulcer (1,0)	0.2950	1.343
Feeding Tube (1,0)	0.4263	1.532
Catheter (1,0)	0.2853	1.330
Dementia (1,0) [1]	-0.2017	0.817
Respiratory Disease (1,0)	0.2138	1.238
Fluid/Electrolyte Disorders (1,0)	0.2016	1.223
Cardiac Arrhythmias (1,0) [1]	0.1968	1.217
Weight Loss (1,0)	0.2086	1.232
Do not Resuscitate (1,0)	-0.3170	0.728
Do not Hospitalize (1,0) [1]	-0.6963	0.498
Female (1,0) [1]	-0.1482	0.862
Hospital Based Facility (1,0) [2]	-0.8297	0.436

N=2,002,478

Logistic Model c-index 0.719

Updated (Uses 2000-2006 SNF Stays)		
Independent Variable	Beta	OR
Intercept	0.0608	
Barthel Score (0 to 90)	-0.0194	0.981
Comorbidity Index (-2.31 to 0.36)	0.8230	2.277
Pressure Ulcer (1,0)	0.3162	1.372
Feeding Tube (1,0)	0.4979	1.645
Catheter (1,0)	0.2184	1.244
Congestive Heart Failure (1,0) [3]	0.2564	1.292
Respiratory Disease (1,0)	0.2171	1.242
Fluid/Electrolyte Disorders (1,0)	0.2056	1.228
Do not Resuscitate (1,0)	-0.3270	0.721

N=13,203,193

Logistic Model c-index 0.712

[1] Original variable that was no longer significant in the updated model.

[2] Original variables intentionally excluded from the updated model.

[3] New significant variable included in the updated model.

Table 3: Change in facility rates of outcome measures for 2000-2006 SNF admissions[1]

	2000	2001	2002	2003	2004	2005	2006	Total
Observed Rates								
Community Discharge								
Original 100 Days	31.15%	30.51%	30.43%	30.44%	30.95%	31.42%	32.07%	
		-0.64	-0.08	0.00	0.51	0.48	0.65	0.92
Updated 100 Days	31.14%	30.51%	30.43%	30.44%	30.95%	31.42%	32.07%	
		-0.63	-0.08	0.00	0.51	0.48	0.65	0.93
Rehospitalized for Any of Five Conditions								
Original 100 Days	14.74%	15.83%	16.43%	17.26%	17.55%	18.04%	18.31%	
		1.09	0.61	0.83	0.28	0.49	0.27	3.57
Updated 100 Days	14.74%	15.82%	16.43%	17.26%	17.55%	18.04%	18.31%	
		1.09	0.61	0.83	0.28	0.49	0.27	3.57
Adjusted Rates								
Community Discharge								
Original 100 Days	33.68%	32.44%	32.32%	32.15%	32.82%	33.82%	34.43%	
		-1.25	-0.11	-0.17	0.67	1.00	0.61	0.75
Updated 100 Days	33.15%	32.34%	32.22%	31.90%	32.24%	32.67%	33.84%	
		-0.81	-0.12	-0.31	0.33	0.43	1.17	0.69
Rehospitalized for Any of Five Conditions								
Original 100 Days	11.79%	13.70%	14.99%	16.55%	17.12%	17.88%	17.96%	
		1.91	1.29	1.57	0.56	0.76	0.08	6.18
Updated 100 Days	13.72%	15.08%	15.96%	17.05%	17.51%	18.08%	18.41%	
		1.37	0.88	1.09	0.46	0.57	0.33	4.69

[1] Table entries show the facility rate of interest on the top row, change from previous year in the bottom row.

Figure 1: Discharge to Community Updated Facility Rank vs. Original Facility Rank

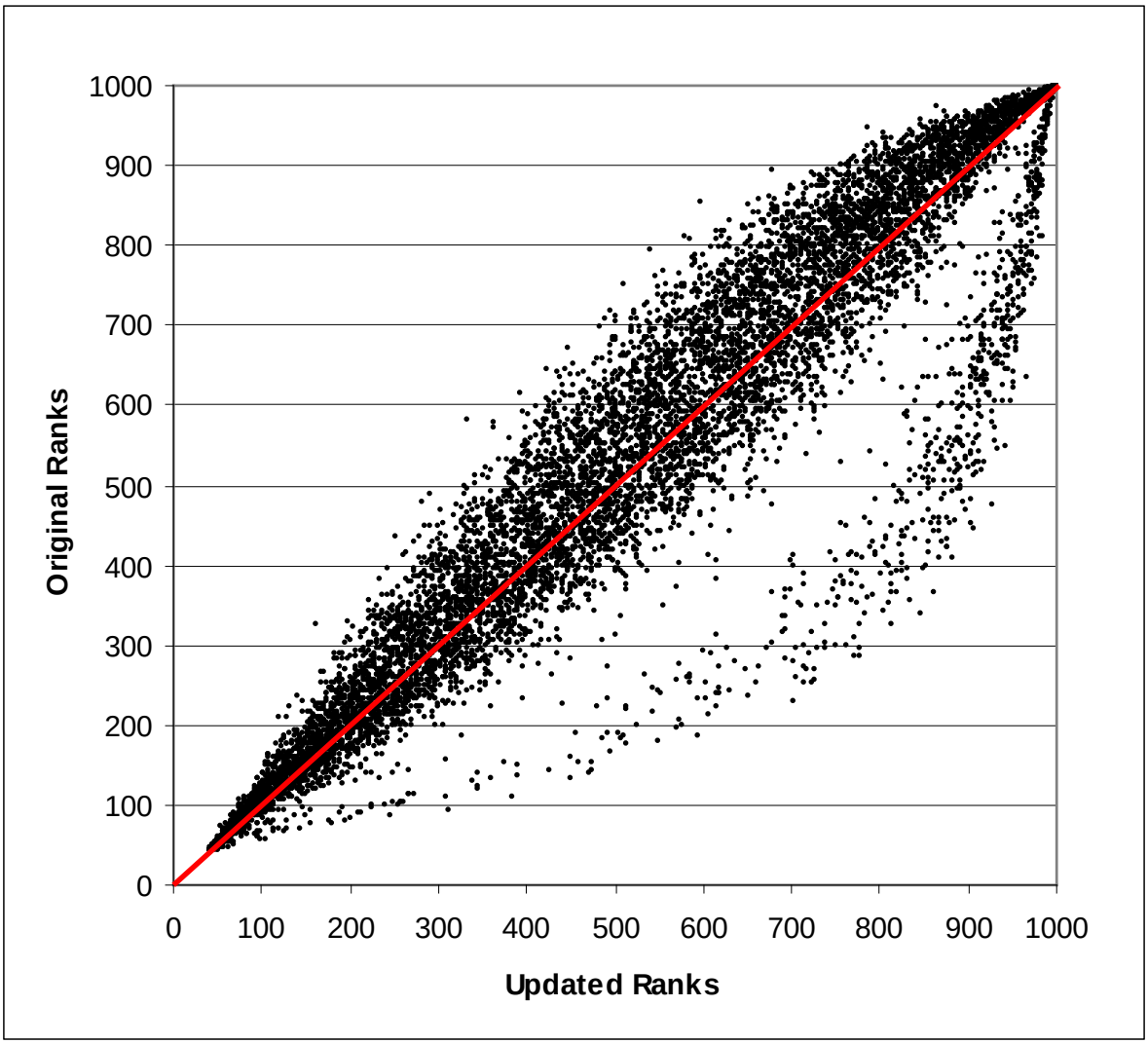

Figure 2: Rehospitalization Updated Facility Rank vs. Original Facility Rank[1]

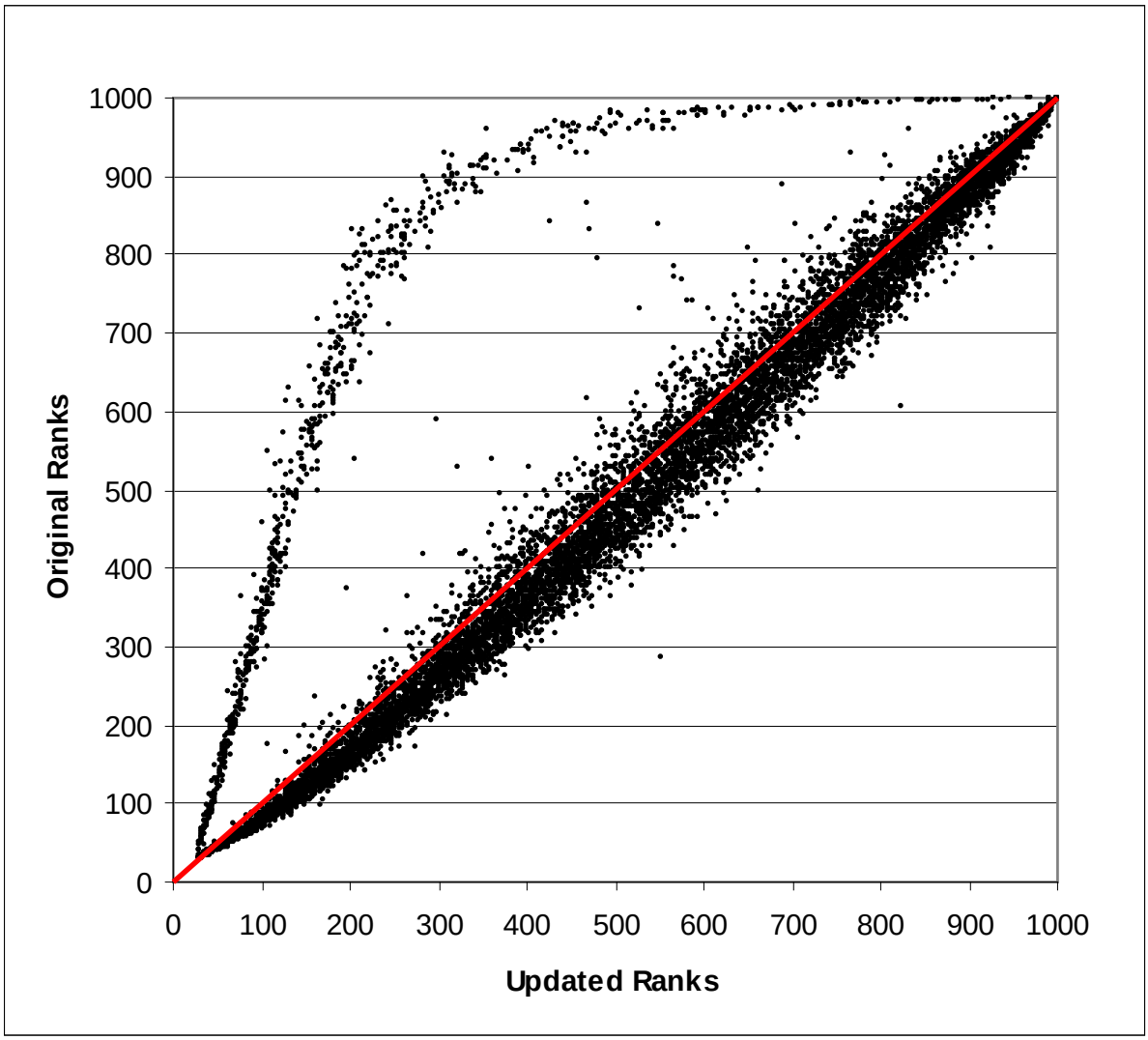

Table 4: Comparison of mean facility measures between 2000 and 2006

	2000 (n=12,201)[1] Mean	(Stdev)	2006 (n=13,528)[2] Mean	(Stdev)
Case mix indicators[3]				
Age (years)	80.53	(3.2)	79.63	(4.1)
Female	66.11%	(9.6)	64.12%	(10.4)
Married	25.47%	(8.9)	27.15%	(8.9)
Do Not Resuscitate orders	39.80%	(22.7)	41.43%	(21.9)
Do Not Hospitalize orders	2.14%	(6.3)	1.90%	(4.8)
Barthel Index (0 to 90)[4]	35.59	(9.3)	34.92	(8.44)
Cognitive Performance Scale (0 to 6)[5]	2.11	(0.7)	1.95	(0.7)
Bowel incontinence Scale (1 to 4) (MDS item H1a)[5]	1.44	(0.7)	1.36	(0.7)
Indwelling catheter (MDS item H3d)	23.39%	(11.4)	23.70%	(12.0)
Feeding tube (MDS item K5b)	10.00%	(8.9)	6.85%	(6.8)
Parenteral/IV feeding (MDS item K5a)	7.44%	(12.9)	14.58%	(17.7)
Pressure ulcer (MDS item M2a, any stage)	24.47%	(11.5)	22.81%	(11.0)
Rehabilitation RUG (Any)	74.64%	(17.2)	82.64%	(14.3)
Rehabilitation RUG – Ultra High	3.12%	(7.7)	10.40%	(15.1)
Rehabilitation RUG – Very High	12.03%	(14.3)	17.76%	(15.0)
Rehabilitation RUG – High	40.96%	(19.0)	16.58%	(13.3)
Rehabilitation RUG – Medium	18.23%	(13.8)	37.78%	(17.3)
Rehabilitation RUG – Low	0.30%	(1.5)	0.12%	(0.9)
Community Discharge Comorbidity Index				
Original (-1.25 to -0.03 for all years)	-0.49	(0.1)	-0.52	(0.1)
Updated (-1.27 to -0.02 for all years)	-0.45	(0.1)	-0.51	(0.1)
Rehospitalization Comorbidity Index				
Original (0.05 to 1.07 for all years)	0.39	(0.1)	0.45	(0.1)
Updated (-2.26 to -1.09 for all years)	-1.87	(0.1)	-1.53	(0.1)
Hospital Stay ICD-9 Based Disease Conditions				
Cardiac arrhythmia	26.26%	(7.4)	28.42%	(7.8)
COPD	22.74%	(7.6)	24.29%	(7.5)
Dementia	24.14%	(11.1)	24.32%	(10.6)
Fluid/Electrolyte disorder	30.35%	(8.8)	33.90%	(8.1)
Fracture	15.77%	(7.2)	13.56%	(6.5)
Genitourinary condition	33.57%	(8.2)	44.36%	(9.0)
Uncomplicated hypertension	37.08%	(8.5)	41.38%	(8.5)
Musculoskeletal disease	27.35%	(9.3)	29.54%	(9.6)
Nervous system disorder	25.22%	(7.7)	26.41%	(7.5)
Respiratory disease	26.37%	(7.6)	28.33%	(7.5)
Skin disorder	12.60%	(6.3)	13.17%	(6.0)
Valvular disease	7.80%	(5.0)	9.54%	(5.6)
MDS Based Disease Conditions				
Depression (MDS)	27.14%	(11.7)	36.69%	(12.8)
Schizophrenia (MDS)	1.93%	(4.0)	2.83%	(5.7)
Congestive Heart Failure (CHF) (MDS)	29.55%	(9.8)	29.75%	(9.7)
LOS of Covered Qualifying Hospitalization (days)	9.26	(2.8)	8.49	(2.3)
Staffing levels				
RN hours/resident-day	0.59	(0.8)	0.43	(0.6)
Licensed nursing hours/resident-day	1.75	(1.2)	1.66	(0.9)
CNA hours/resident-day	2.30	(0.8)	2.46	(0.8)
The Dartmouth Atlas of Health Care				
# of Primary Care Physicians per 100,000 Residents	N/A	-	71.63	(11.5)
% of Decedents Hospitalized in Last 6 Months of Life	70.57%	(4.3)	71.20%[6]	(4.2)

Table 4: Comparison of mean facility measures between 2000 and 2006 (Continued)

	2000 (n=12,201)[1]		2006 (n=13,528)[2]	
	Mean	(Stdev)	Mean	(Stdev)
Geographic Region				
Northeast	20.74%	-	18.83%	-
Midwest	30.65%	-	31.99%	-
South	33.17%	-	34.79%	-
West	15.44%	-	14.39%	-
Facility characteristics				
Hospital-based	13.33%	-	7.41%	-
Freestanding	86.67%	-	92.59%	-
Urban	71.16%	-	68.36%	-
Rural	28.84%	-	31.64%	-
For-profit	67.00%	-	68.71%	-
Non-profit	28.39%	-	27.11%	-
Government	4.61%	-	4.18%	-

[1] Sample for 2000 is facilities with non-missing data in 2000 for rehospitalization in 100 days and community discharge in 100 days with 25 or more SNF stays.

[2] Sample for 2006 is facilities with non-missing data in 2006 for rehospitalization in 100 days and community discharge in 100 days with 25 or more SNF stays.

[3] Values are interpreted as “Mean % of residents in the facility with this condition,” or as “Mean average resident value in the facility for this item”.

[4] Higher values indicate better functional status.

[5] Lower values indicate better functional status.

[6] Figures for 2005 used due to 2006 figures not available.

Table 5A: Community discharge within 100 days regression model series (original)

Step	Variables in model	Model adj R^2	Coefficient of tested variable	Coefficient of time	Coefficient of 2000 only	Coefficient of 2006 only
1	Time	.0005	-	.00920	-	-
2	Time, presence at 2000 only and 2006 only indicators	.0355	-	.04033	.14471	-.07379
3	Time, presence at 2000 only and 2006 only indicators, case mix	.6006	-	.01070	.05443	-.04263
4	Step 3 and hospital LOS	.6013	-.00285	.00881	.05336	-.04273
5	Step 3 and region (Northeast, Midwest, South)	.6140	-.05432 NE -.07994 MW -.03954 S	.00421	.05285	-.04234
6	Step 3 and hospital-based	.6300	.14214	.00918	.01323	-.04278
7	Step 3 and ownership (for-profit, government)	.6014	-.01347 profit -.00494 gov	.01001	.05267	-.04303
8	Step 3 and urban	.6029	.02811	.01488	.05417	-.04098
9	Step 3 and RN hours/resident-day	.6147	.05471	.01585	.01339	-.04231
10	Step 3 and licensed nursing hours/resident-day	.6200	.03845	.01051	.00613	-.04423
11	Step 3 and CNA hours/resident-day	.5946	.01421	.00811	.04539	-.04504
12	Step 3 and RN hours/resident-day, licensed nursing hours/resident-day, CNA hours/resident-day	.6219	.02001 RN .02762 lic nsg .00656 CNA	.01116	.00454	-.04378

Table 5B: Community discharge within 100 days regression model series (updated)

Step	Variables in model	Model adj R^2	Coefficient of tested variable	Coefficient of time	Coefficient of 2000 only	Coefficient of 2006 only
1	Time	.0005	-	.00928	-	-
2	Time, presence at 2000 only and 2006 only indicators	.0355	-	.04041	.14482	-.07371
3	Time, presence at 2000 only and 2006 only indicators, case mix	.6449	-	.01629	.04356	-.03620
4	Step 3 and hospital LOS	.6454	-.00234	.01440	.04269	-.03629
5	Step 3 and region (Northeast, Midwest, South)	.6522	-.03411 NE -.06155 MW -.03755 S	.01042	.04342	-.03524
6	Step 3 and hospital-based	.6641	.11884	.01232	.01181	-.03655
7	Step 3 and ownership (for-profit, government)	.6458	-.01501 profit -.00847 gov	.01538	.04173	-.03650
8	Step 3 and urban	.6475	.03031	.02083	.04278	-.03396
9	Step 3 and RN hours/resident-day	.6515	.04398	.01706	.01247	-.03573
10	Step 3 and licensed nursing hours/resident-day	.6548	.03092	.01290	.00687	-.03749
11	Step 3 and CNA hours/resident-day	.6394	.01222	.01287	.03675	-.03783
12	Step 3 and RN hours/resident-day, licensed nursing hours/resident-day, CNA hours/resident-day	.6562	.01666 RN .02184 lic nsg .00620 CNA	.01317	.00558	-.03716
13	Step 3 and primary care physicians per 100,000 residents	.6276	.00114	.01716	-.01130	-.03377
14	Step 3 and state indicators	.6793	Largest effect: .28084 MT (W) vs. ND (MW)	.02129	.04737	-.02619

Table 6A: Community discharge within 100 days final regression model without staffing variables

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.47844		<0.0001	0.60514		<0.0001
Time	0.00622		0.0068	0.00879		0.0018
2000 only indicator	0.01087		0.0032	0.00998		0.0047
2006 only indicator	-0.04074		<0.0001	-0.03381		<0.0001
Age (years)	-0.00099	-0.01838	0.0009	-0.00372	-0.06869	<0.0001
Female	-	-	-	0.08159	0.04032	<0.0001
DNR orders	-0.10090	-0.11090	<0.0001	-0.08594	-0.09448	<0.0001
Barthel Index score (0-90)[2]	0.00102	0.04438	<0.0001	0.00134	0.05864	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	-0.04647	-0.15365	<0.0001	-0.04035	-0.13342	<0.0001
Cognitive Performance Scale score (0-6)[3]	-0.04548	-0.16107	<0.0001	-0.02948	-0.10441	<0.0001
Indwelling catheter (MDS item H3d)	0.04803	0.02783	<0.0001	0.03437	0.01992	<0.0001
Feeding Tube (MDS item K5b)	-	-	-	-0.06020	-0.02393	<0.0001
Parenteral/IV feedings (MDS item K5a)	0.05513	0.04351	<0.0001	0.05442	0.04295	<0.0001
Rehabilitation RUG (Any)	0.16273	0.13046	<0.0001			
– Ultra High				0.14275	0.08913	<0.0001
– Very High				0.17498	0.12846	<0.0001
– High				0.10700	0.10686	<0.0001
– Medium				0.12728	0.11603	<0.0001
– Low				-0.04520	-0.00274	0.4562
Community discharge comorbidity index	0.09114	0.05511	<0.0001	0.08044	0.05056	<0.0001
Fracture	0.13974	0.04732	<0.0001	0.11393	0.03859	<0.0001
Cardiac arrhythmia	0.09769	0.03692	<0.0001	0.07369	0.02786	<0.0001
COPD	-0.05824	-0.02176	<0.0001	-	-	-
Dementia	-0.23806	-0.12738	<0.0001	-0.19306	-0.10332	<0.0001
Genitourinary condition	-0.11642	-0.05822	<0.0001	-0.11185	-0.05594	<0.0001
Uncomplicated hypertension	0.05419	0.02338	<0.0001	0.05072	0.02188	<0.0001
Musculoskeletal disease	0.20266	0.09482	<0.0001	0.15029	0.07032	<0.0001
Nervous system disorder	-	-	-	-0.04231	-0.01585	0.0007
Skin disorder	-0.08284	-0.02503	<0.0001	-0.06015	-0.01818	<0.0001
Valvular disease	0.19799	0.05225	<0.0001	0.15674	0.04137	<0.0001
Married				0.30839	0.13569	<0.0001
Depression				-0.09889	-0.06405	<0.0001
Schizophrenia				-0.32691	-0.08078	<0.0001
CHF				-0.10165	-0.04871	<0.0001
LOS of covered qualifying hospitalization (days)	-0.00373	-0.04712	<0.0001	-0.00354	-0.04476	<0.0001
Northeast	-0.04321		<0.0001	-0.02552		<0.0001
Midwest	-0.07023		<0.0001	-0.05516		<0.0001
South	-0.03293		<0.0001	-0.03060		<0.0001
Hospital-based	0.14643		<0.0001	0.12188		<0.0001

Table 6A: Community discharge within 100 days final regression model without staffing variables (Continued)

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
For-profit	0.00813		<0.0001	0.00347		0.0664
Government	-0.01422		0.0003	-0.01541		<0.0001
Urban	0.02811		<0.0001	0.02759		<0.0001
Adjusted R^2 =		0.6457			0.6741	

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 6B: Community discharge within 100 days final regression model with staffing variables

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.44953		<0.0001	0.57142		<0.0001
Time	0.00567		0.0162	0.00679		0.0189
2000 only indicator	-0.00496		0.2305	-0.00236		0.5530
2006 only indicator	-0.04165		<0.0001	-0.03478		<0.0001
Age (years)	-0.00105	-0.02001	0.0006	-0.00362	-0.06901	<0.0001
Female	-	-	-	0.07554	0.03831	<0.0001
DNR orders	-0.09175	-0.10266	<0.0001	-0.07936	-0.08882	<0.0001
Barthel Index score (0-90)[2]	0.00067	0.02931	<0.0001	0.00102	0.04492	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	-0.04869	-0.16371	<0.0001	-0.04221	-0.14195	<0.0001
Cognitive Performance Scale score (0-6)[3]	-0.04364	-0.15661	<0.0001	-0.02839	-0.10192	<0.0001
Indwelling catheter (MDS item H3d)	0.03287	0.01928	<0.0001	0.02397	0.01407	0.0007
Feeding Tube (MDS item K5b)				-0.06680	-0.02702	<0.0001
Parenteral/IV feedings (MDS item K5a)	0.04751	0.03856	<0.0001	0.04742	0.03849	<0.0001
Rehabilitation RUG (Any)	0.15042	0.12251	<0.0001			
– Ultra High				0.13040	0.08444	<0.0001
– Very High				0.16378	0.12254	<0.0001
– High				0.09758	0.09820	<0.0001
– Medium				0.12153	0.11328	<0.0001
– Low				-0.12189	-0.00740	0.0552
Community discharge comorbidity index	0.07931	0.04867	<0.0001	0.07117	0.04530	<0.0001
Fracture	0.17262	0.05916	<0.0001	0.13789	0.04727	<0.0001
Cardiac arrhythmia	0.08941	0.03464	<0.0001	0.06624	0.02567	<0.0001
COPD	-0.06715	-0.02559	<0.0001	-	-	-
Dementia	-0.22989	-0.12515	<0.0001	-0.18897	-0.10289	<0.0001
Genitourinary condition	-0.10905	-0.05534	<0.0001	-0.10817	-0.05491	<0.0001
Uncomplicated hypertension	0.05964	0.02617	<0.0001	0.05832	0.02560	<0.0001
Musculoskeletal disease	0.19167	0.09041	<0.0001	0.14901	0.07030	<0.0001
Nervous system disorder	-	-	-	-0.04365	-0.01669	0.0006
Skin disorder	-0.08402	-0.02590	<0.0001	-0.05950	-0.01834	0.0002
Valvular disease	0.18904	0.05119	<0.0001	0.14997	0.04062	<0.0001
Married				0.30159	0.13460	<0.0001
Depression				-0.09362	-0.06170	<0.0001
Schizophrenia				-0.31025	-0.07881	<0.0001
CHF				-0.10061	-0.04906	<0.0001
LOS of covered qualifying hospitalization (days)	-0.00353	-0.04517	<0.0001	-0.00327	-0.04189	<0.0001
Northeast	-0.04389		<0.0001	-0.02723		<0.0001
Midwest	-0.06935		<0.0001	-0.05502		<0.0001
South	-0.03676		<0.0001	-0.03363		<0.0001
Hospital-based	0.09636		<0.0001	0.08208		<0.0001
For-profit	0.01174		<0.0001	0.00650		0.0009

Table 6B: Community discharge within 100 days final regression model with staffing variables (Continued)

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Government	-0.01298		0.0017	-0.01473		0.0002
Urban	0.02321		<0.0001	0.02383		<0.0001
Licensed nursing hours/resident-day	0.02407	0.12641	<0.0001	0.01911	0.10035	<0.0001
CNA hours/resident-day	0.00434	0.01742	<0.0001	0.00453	0.01819	<0.0001
Adjusted R^2 =		0.6434			0.6708	

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 6C: Community discharge within 100 days final regression model with staffing plus alternative geographic variables (updated)

Variable	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.21532		<0.0001
Time	0.01867		<0.0001
2000 only indicator	-0.01465		0.0467
2006 only indicator	-0.02598		<0.0001
Age (years)	-0.00132	-0.02576	0.0002
Female	0.06678	0.03479	<0.0001
DNR orders	-0.09490	-0.10839	<0.0001
Barthel Index score (0-90)[2]	0.00171	0.07539	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	-0.03290	-0.11277	<0.0001
Cognitive Performance Scale score (0-6)[3]	-0.02915	-0.10594	<0.0001
Indwelling catheter (MDS item H3d)	0.03114	0.01857	<0.0001
Feeding Tube (MDS item K5b)	-0.05553	-0.02290	0.0002
Parenteral/IV feedings (MDS item K5a)	0.04155	0.03467	<0.0001
Rehabilitation RUG – Ultra High	0.12227	0.08211	<0.0001
– Very High	0.14529	0.11122	<0.0001
– High	0.09094	0.09289	<0.0001
– Medium	0.09833	0.09405	<0.0001
– Low	-0.14417	-0.00823	0.0347
Community discharge comorbidity index	0.08431	0.05418	<0.0001
Fracture	0.14602	0.05129	<0.0001
Cardiac arrhythmia	0.03167	0.01259	0.0096
COPD	-	-	-
Dementia	-0.20766	-0.11459	<0.0001
Genitourinary condition	-0.11734	-0.06050	<0.0001
Uncomplicated hypertension	0.05262	0.02364	<0.0001
Musculoskeletal disease	0.15014	0.07220	<0.0001
Nervous system disorder	-0.02482	-0.00970	0.0463
Skin disorder	-0.03256	-0.01026	0.0393
Valvular disease	0.13976	0.03887	<0.0001
Married	0.29585	0.13429	<0.0001
Depression	-0.08504	-0.05674	<0.0001
Schizophrenia	-0.28638	-0.07480	<0.0001
CHF	-0.08184	-0.04083	<0.0001
LOS of covered qualifying hospitalization (days)	-0.00276	-0.03596	<0.0001
States (see Table 6D)			
Hospital-based	0.07953		<0.0001
For-profit	0.00343		0.0773
Government	-0.02090		<0.0001
Urban	0.02009		<0.0001
Licensed nursing hours/resident-day	0.01763	0.08392	<0.0001
CNA hours/resident-day	-	-	-
Primary care physicians per 100,000 residents	0.00046	0.02730	<0.0001
Adjusted R^2 = 0.6814			

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 6D: Community discharge within 100 days final regression model with staffing plus alternative geographic variables (updated) – state variation

State_Region[1]	Coefficient	Standardized Coefficient[2]	p-value
OK_S	0.04207		0.0016
IA_MW	0.04532		0.0002
NE_MW	0.04596		0.0006
LA_S	0.05192		<0.0001
IL_MW	0.05416		<0.0001
RI_NE	0.05837		0.0001
MO_MW	0.07059		<0.0001
KS_MW	0.07132		<0.0001
MN_MW	0.07275		<0.0001
SD_MW	0.07333		<0.0001
TX_S	0.07879		<0.0001
PA_NE	0.08542		<0.0001
KY_S	0.08631		<0.0001
IN_MW	0.08777		<0.0001
WI_MW	0.09289		<0.0001
NJ_NE	0.09295		<0.0001
GA_S	0.09484		<0.0001
NC_S	0.10124		<0.0001
AR_S	0.11104		<0.0001
MS_S	0.11140		<0.0001
MI_MW	0.11261		<0.0001
FL_S	0.11408		<0.0001
NY_NE	0.11462		<0.0001
DE_S	0.11478		<0.0001
CO_W	0.11654		<0.0001
WY_W	0.11731		<0.0001
NH_NE	0.11973		<0.0001
NV_W	0.12460		<0.0001
CA_W	0.12545		<0.0001
MD_S	0.12884		<0.0001
MA_NE	0.13623		<0.0001
AL_S	0.13639		<0.0001
DC_S	0.13691		<0.0001
WV_S	0.13739		<0.0001
OH_MW	0.14060		<0.0001
NM_W	0.14178		<0.0001
CT_NE	0.14217		<0.0001
VA_S	0.14312		<0.0001
TN_S	0.14869		<0.0001
HI_W	0.14881		<0.0001
ID_W	0.15034		<0.0001
UT_W	0.15218		<0.0001
WA_W	0.15404		<0.0001
VT_NE	0.16062		<0.0001
ME_NE	0.16700		<0.0001
AK_W	0.17060		<0.0001
AZ_W	0.17773		<0.0001
OR_W	0.19336		<0.0001
SC_S	0.22685		<0.0001

Table 6D: Community discharge within 100 days final regression model with staffing plus alternative geographic variables (updated) – state variation (Continued)

State_Region[1]	Coefficient	Standardized Coefficient[2]	p-value
MT_W	0.28314		<0.0001

[1] ND_MW as reference

[2] Coefficient of the standardized (mean=0, variance=1) variable.

Table 7A: Rehospitalization within 100 days regression model series (original)

Step	Variables in model	Model adj R^2	Coefficient of tested variable	Coefficient of time	Coefficient of 2000 only	Coefficient of 2006 only
1	Time	.0472	-	.03571	-	-
2	Time, presence at 2000 only and 2006 only indicators	.0586	-	.03354	-.03753	-.01059
3	Time, presence at 2000 only and 2006 only indicators, case mix	.5065	-	.01745	-.02328	-.00235
4	Step 3 and hospital LOS	.5068	.00078	.01793	-.02296	-.00235
5	Step 3 and region (Northeast, Midwest, South)	.5144	.02548 NE .02098 MW .01713 S	.01864	-.02208	-.00205
6	Step 3 and hospital-based	.5334	-.05372	.01817	-.00694	-.00253
7	Step 3 and ownership (for-profit, government)	.5201	.02065 profit -.00966 gov	.01901	-.01940	-.00184
8	Step 3 and urban	.5070	-.00284	.01712	-.02324	-.00273
9	Step 3 and RN hours/resident-day	.5165	-.01731	.01667	-.01017	-.00339
10	Step 3 and licensed nursing hours/resident-day	.5172	-.01118	.01836	-.00882	-.00280
11	Step 3 and CNA hours/resident-day	.5038	-.00390	.01870	-.02070	-.00245
12	Step 3 and RN hours/resident-day, licensed nursing hours/resident-day, CNA hours/resident-day	.5189	-.00902 RN -.00651 lic nsg -.00163 CNA	.01788	-.00802	-.00306

Table 7B: Rehospitalization within 100 days regression model series (updated)

Step	Variables in model	Model adj R^2	Coefficient of tested variable	Coefficient of time	Coefficient of 2000 only	Coefficient of 2006 only
1	Time	.0472	-	.03571	-	-
2	Time, presence at 2000 only and 2006 only indicators	.0586	-	.03354	-.03753	-.01059
3	Time, presence at 2000 only and 2006 only indicators, case mix	.5138	-	-.02227	-.02074	-.00235
4	Step 3 and hospital LOS	.5142	.00087	-.02150	-.02038	-.00233
5	Step 3 and region (Northeast, Midwest, South)	.5221	.02706 NE .02127 MW .01811 S	-.01770	-.01985	-.00184
6	Step 3 and hospital-based	.5362	-.05094	-.01947	-.00668	-.00246
7	Step 3 and ownership (for-profit, government)	.5256	.01922 profit -.00948 gov	-.01921	-.01742	-.00200
8	Step 3 and urban	.5143	-.00340	-.02288	-.02064	-.00278
9	Step 3 and RN hours/resident-day	.5203	-.01571	-.02116	-.00992	-.00324
10	Step 3 and licensed nursing hours/resident-day	.5211	-.01030	-.02018	-.00859	-.00263
11	Step 3 and CNA hours/resident-day	.5105	-.00378	-.02087	-.01882	-.00238
12	Step 3 and RN hours/resident-day, licensed nursing hours/resident-day, CNA hours/resident-day	.5225	-.00789 RN -.00620 lic nsg -.00172 CNA	-.02006	-.00792	-.00286
13	Step 3 and decedents hospitalized in last 6 months of life	.5202	.00184	-.02247	-.02126	-.0.296
14	Step 3 and state indicators	.5378	Largest effect: .09150 CT (NE) vs. HI (S)	-.01815	-.01843	-.00085

Table 8A: Rehospitalization within 100 days final regression model without staffing variables

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.01073		0.3709	0.31397		<0.0001
Time	0.01988		<0.0001	-0.01437		<0.0001
2000 only indicator	-0.00604		0.0003	-0.00595		0.0004
2006 only indicator	-0.00209		0.0909	-0.00180		0.1434
Age (years)	0.00045	0.02053	0.0003	-	-	-
DNR orders	-0.03430	-0.09334	<0.0001	-0.03597	-0.09789	<0.0001
Do not hospitalize orders	-0.02154	-0.01468	0.0008	-0.02286	-0.01558	0.0004
Barthel Index (0-90)[2]	-0.00105	-0.11378	<0.0001	-0.00089	-0.09612	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	0.01464	0.11988	<0.0001	0.01358	0.11117	<0.0001
Cognitive Performance Scale (0-6)[3]	-0.00203	-0.01776	0.0158	-	-	-
Feeding tube (MDS item K5b)	0.17497	0.17199	<0.0001	0.16800	0.16515	<0.0001
Parenteral/IV feedings (MDS item K5a)	-0.00504	-0.00983	0.0298	-	-	-
Pressure ulcer (MDS item M2a, any stage)	0.05141	0.07085	<0.0001	0.04929	0.06793	<0.0001
Rehabilitation RUG (Any)	0.03440	0.06837	<0.0001			
– Ultra High				0.05589	0.08639	<0.0001
– Very High				0.03700	0.06723	<0.0001
– High				0.03351	0.08284	<0.0001
– Medium				0.03125	0.07051	<0.0001
– Low				-0.01641	-0.00247	0.5676
Rehospitalization case mix index	0.15645	0.16708	<0.0001	0.12500	0.28794	<0.0001
Fracture	-0.11566	-0.09698	<0.0001	-0.10437	-0.08751	<0.0001
COPD	0.01596	0.01477	0.0021	-	-	-
Fluid/Electrolyte disorder	0.06644	0.06960	<0.0001	0.06316	0.06616	<0.0001
Genitourinary condition	0.04063	0.05031	<0.0001	0.04710	0.05832	<0.0001
Musculoskeletal disease	-0.03976	-0.04605	<0.0001	-0.03327	-0.03853	<0.0001
Nervous system disorder	-0.04803	-0.04457	<0.0001	-0.04833	-0.04484	<0.0001
Respiratory disease	-	-	-	0.03150	0.02931	<0.0001
Skin disorder	0.07946	0.05949	<0.0001	0.08935	0.06689	<0.0001
Valvular disease	-0.06576	-0.04299	<0.0001	-0.06047	-0.03953	<0.0001
Married				-0.01760	-0.01918	<0.0001
Depression				-0.00969	-0.01553	0.0033
Schizophrenia				-	-	-
CHF				0.05079	0.06027	<0.0001
Northeast	0.02579		<0.0001	0.02788		<0.0001
Midwest	0.02104		<0.0001	0.02175		<0.0001
South	0.01746		<0.0001	0.01857		<0.0001
Hospital-based	-0.04372		<0.0001	-0.04153		<0.0001
For-profit	0.01429		<0.0001	0.01370		<0.0001
Government	-0.00532		0.0032	-0.00567		0.0016
Urban	-0.00316		0.0002	-0.00250		0.0039
Adjusted R^2 =		0.5461			0.5492	

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 8B: Rehospitalization within 100 days final regression model with staffing variables

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.00262		0.8332	0.31739		<0.0001
Time	0.02041		<0.0001	-0.01317		<0.0001
2000 only indicator	-0.00276		0.1489	-0.00285		0.1344
2006 only indicator	-0.00221		0.0791	-0.00193		0.1206
Age (years)	0.00060	0.02786	<0.0001	-	-	-
DNR orders	-0.03647	-0.09927	<0.0001	-0.03761	-0.10241	<0.0001
Do not hospitalize orders	-0.01772	-0.01206	0.0086	-0.02015	-0.01369	0.0027
Barthel Index (0-90)[2]	-0.00098	-0.10476	<0.0001	-0.00081	-0.08702	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	0.01422	0.11631	<0.0001	0.01305	0.10683	<0.0001
Cognitive Performance Scale (0-6)[3]	-0.00260	-0.02272	0.0029	-	-	-
Feeding tube (MDS item K5b)	0.18139	0.17828	<0.0001	0.17078	0.16777	<0.0001
Parenteral/IV feedings (MDS item K5a)	-	-	-	-	-	-
Pressure ulcer (MDS item M2a, any stage)	0.05712	0.07882	<0.0001	0.05421	0.07480	<0.0001
Rehabilitation RUG (Any)	0.03565	0.07071	<0.0001			
– Ultra High				0.05591	0.08818	<0.0001
– Very High				0.03601	0.06554	<0.0001
– High				0.03154	0.07716	<0.0001
– Medium				0.03108	0.07050	<0.0001
– Low				-0.02401	-0.00355	0.4330
Rehospitalization case mix index	0.15534	0.16631	<0.0001	0.12441	0.28557	<0.0001
Fracture	-0.12150	-0.10131	<0.0001	-0.11017	-0.09188	<0.0001
COPD	0.02209	0.02049	<0.0001	-	-	-
Fluid/Electrolyte disorder	0.06544	0.06850	<0.0001	0.06215	0.06506	<0.0001
Genitourinary condition	0.03763	0.04647	<0.0001	0.04251	0.05250	<0.0001
Musculoskeletal disease	-0.04080	-0.04681	<0.0001	-0.03556	-0.04089	<0.0001
Nervous system disorder	-0.04737	-0.04408	<0.0001	-0.04803	-0.04470	<0.0001
Respiratory disease	-	-	-	0.03728	0.03459	<0.0001
Skin disorder	0.08396	0.06295	<0.0001	0.09220	0.06915	<0.0001
Valvular disease	-0.06262	-0.04124	<0.0001	-0.05959	-0.03927	<0.0001
Married				-0.01436	-0.01561	0.0024
Depression				-0.01285	-0.02060	0.0002
Schizophrenia				-0.01783	-0.01102	0.0388
CHF				0.05257	0.06242	<0.0001
Northeast	0.02477		<0.0001	0.02736		<0.0001
Midwest	0.02103		<0.0001	0.02236		<0.0001
South	0.01820		<0.0001	0.01968		<0.0001
Hospital-based	-0.03354		<0.0001	-0.03187		<0.0001
For-profit	0.01380		<0.0001	0.01342		<0.0001
Government	-0.00622		0.0012	-0.00661		0.0005
Urban	-0.00209		0.0195			
Licensed nursing hours/resident-day	-0.00485	-0.06189	<0.0001	-0.00471	-0.06020	<0.0001

Table 8B: Rehospitalization within 100 days final regression model with staffing variables (Continued)

	Original			Updated		
Variable	Coefficient	Standardized Coefficient[1]	p-value	Coefficient	Standardized Coefficient[1]	p-value
Adjusted R^2 =		0.5411			0.5441	

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 8C: Rehospitalization within 100 days final regression model with staffing plus alternative geographic variables (updated)

Variable	Coefficient	Standardized Coefficient[1]	p-value
Intercept	0.15463		<0.0001
Time	-0.01670		<0.0001
2000 only indicator	-0.00149		0.4283
2006 only indicator	-0.00016		0.8997
Age (years)	-	-	-
DNR orders	-0.03833	-0.10430	<0.0001
Do not hospitalize orders	-0.02390	-0.01625	0.0005
Barthel Index (0-90)[2]	-0.00077	-0.08254	<0.0001
Bowel incontinence scale (1-4) (MDS item H1a)[3]	0.01281	0.10473	<0.0001
Cognitive Performance Scale (0-6)[3]	-	-	-
Feeding tube (MDS item K5b)	0.17659	0.17355	<0.0001
Parenteral/IV feedings (MDS item K5a)	-	-	-
Pressure ulcer (MDS item M2a, any stage)	0.04450	0.06135	<0.0001
Rehabilitation RUG – Ultra High	0.05972	0.09409	<0.0001
– Very High	0.03421	0.06221	<0.0001
– High	0.03359	0.08216	<0.0001
– Medium	0.03167	0.07172	<0.0001
– Low	-0.02092	-0.00309	0.4889
Rehospitalization case mix index	0.12628	0.28979	<0.0001
Fracture	-0.09826	-0.08191	<0.0001
COPD	-	-	-
Fluid/Electrolyte disorder	0.05930	0.06202	<0.0001
Genitourinary condition	0.04911	0.06059	<0.0001
Musculoskeletal disease	-0.03470	-0.03980	<0.0001
Nervous system disorder	-0.04284	-0.03983	<0.0001
Respiratory disease	0.03309	0.03063	<0.0001
Skin disorder	0.08424	0.06314	<0.0001
Valvular disease	-0.04946	-0.03255	<0.0001
Married	-	-	-
Depression	-	-	-
Schizophrenia	-0.02185	-0.01350	0.0083
CHF	0.05174	0.06136	<0.0001
States (see Table 8D)			
Hospital-based	-0.03385		<0.0001
For-profit	0.01297		<0.0001
Government	-0.00687		0.0003
Urban	-0.00283		0.0022
Licensed nursing hours/resident-day	-0.00446	-0.05687	<0.0001
Decedents hospitalized in last 6 months of life	0.00198	0.10234	<0.0001

Adjusted R^2 = 0.5631

[1] Coefficient of the standardized (mean=0, variance=1) variable.

[2] Higher values indicate better status.

[3] Lower values indicate better status.

Table 8D: Rehospitalization within 100 days final regression model with staffing plus alternative geographic variables (updated) – state variation

State_Region[1]	Coefficient	Standardized Coefficient[2]	p-value
AL_S	0.01476		0.1037
CA_W	0.01832		0.0337
LA_S	0.02121		0.0200
NV_W	0.02131		0.0505
IA_MW	0.02205		0.0133
NM_W	0.02417		0.0169
WA_W	0.02505		0.0050
AR_S	0.02551		0.0052
UT_W	0.02754		0.0049
TX_S	0.02883		0.0009
ME_NE	0.02888		0.0024
SC_S	0.02907		0.0014
FL_S	0.02965		0.0007
ND_MW	0.03009		0.0031
DE_S	0.03017		0.0056
GA_S	0.03065		0.0005
PA_NE	0.03163		0.0003
KS_MW	0.03207		0.0004
OH_MW	0.03345		0.0001
SD_MW	0.03456		0.0006
NE_MW	0.03476		0.0002
IN_MW	0.03588		<0.0001
OR_W	0.03625		0.0001
NJ_NE	0.03706		<0.0001
VT_NE	0.03721		0.0009
NC_S	0.03725		<0.0001
AZ_W	0.03739		<0.0001
AK_W	0.03858		0.0650
MO_MW	0.03943		<0.0001
CO_W	0.03996		<0.0001
DC_S	0.04098		0.0023
WI_MW	0.04131		<0.0001
VA_S	0.04164		<0.0001
MS_S	0.04337		<0.0001
WV_S	0.04412		<0.0001
MD_S	0.04426		<0.0001
KY_S	0.04462		<0.0001
TN_S	0.04466		<0.0001
MA_NE	0.04505		<0.0001
MT_W	0.04595		<0.0001
OK_S	0.04750		<0.0001
NH_NE	0.04836		<0.0001
ID_W	0.05143		<0.0001
RI_NE	0.05187		<0.0001
MN_MW	0.05306		<0.0001
MI_MW	0.05367		<0.0001
IL_MW	0.05429		<0.0001
NY_NE	0.05796		<0.0001
WY_W	0.06687		<0.0001

Table 8D: Rehospitalization within 100 days final regression model with staffing plus alternative geographic variables (updated) – state variation (Continued)

State_Region[1]	Coefficient	Standardized Coefficient[2]	p-value
CT_NE	0.07051		<0.0001

[1] HI_W as reference.

[2] Coefficient of the standardized (mean=0, variance=1) variable.